Analysis of Expansion of Access to Care Through Use of Telemedicine and Mobile Health Services

REPORT 2: CASE STUDIES AND CURRENT STATUS OF TELEMEDICINE

by

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EXECUTIVE SUMMARY

This report has four major objectives. The first objective is to discuss information obtained during the course of case studies conducted under this contract. The second objective is to assess the current status of telemedicine on the basis of the case studies. The third objective is to further refine the analytic framework presented in Report 1 by providing a taxonomic system for classifying telemedicine applications. The fourth objective is to discuss several general issues of practical relevance to telemedicine.

The case studies involved visits to eight sites with telemedicine programs. These included five academic medical centers, one private hospital, one U.S. Army medical center, and NASA headquarters in Houston. In addition, we conducted telephone interviews with the directors of several other telemedicine programs.

No blanket endorsement of telemedicine's effectiveness can be made at this point. There are very many areas in which telemedicine appears to be medically safe and effective, and acceptable to patients. There is also little question that in remote rural areas, telemedicine has the capacity to increase access to medical care. Although some data are available on the costs of telemedicine, there are insufficient data to support the contention that telemedicine is a cost-effective means of health care delivery. While in certain specific situations it seems to be cost effective, the issue is complex and demands considerable study. We believe that a full understanding of the costs and benefits of telemedicine will be difficult to accomplish until telemedicine has been relatively well integrated into the ordinary system of delivery of medical care and systematically evaluated from a health services research perspective. This could take several years.

The taxonomic scheme we offer is based on two factors: 1) what is known about the effectiveness of various telemedicine applications, and what research remains to be done; and 2) various processes of health care delivery that cut across lines of specialization. The resulting taxonomy contains four categories of telemedicine application. The first category includes telemedicine applications that are widely thought to be effective, and require research on patterns of reimbursement and costs to the system. A medical or surgical followup consult is an example of one of these applications. The second category includes applications that are assumed to be effective, but whose possible impact on the system is unknown. For these, the research that needs to be conducted deals with health services issues such as practice patterns, role of nonphysician providers, costs, and related matters. The third category includes those areas of telemedicine which have not yet been demonstrated to be effective, or on which more basic research remains to be done in order to establish minimal standards. The detection of nondisplaced fractures, for example, is significantly more difficult using digital images than conventional radiographs. The fourth category includes applications which are currently experimental, or which anticipate future integration of various advanced technologies.

We address a number of issues that appear to arise frequently for telemedicine programs. We attempted to study the ways in which the various programs we visited have tried to deal with these issues, and made judgments regarding the extent to which these appeared to be effective or ineffective. In particular we focused on provider resistance to using telemedicine, administrative support, funding, centralized scheduling and coordination, and the various levels of care.

Telemedicine appears to be generally effective, but there is no way to anticipate the possible impact of this technology on programs administered by HCFA and on the entire health care delivery system without considerable research.

TABLE OF CONTENTS

Chapter **Page**

1. INTRODUCTION . . . 1.1
   A. Project and Report Overview . . . 1.1
      1. Project Overview . . . 1.1
      2. Outline of the Current Report . . . 1.1
   B. The Case Studies . . . 1.1
      1. Approach to the Case Studies . . . 1.1
      2. Objectives of the Case Studies . . . 1.2
      3. Site Selection . . . 1.2

2. TELEMEDICINE CASE STUDIES . . . 2.1
   A. Description of Individual Telemedicine Programs . . . 2.1
      1. Oregon Health Sciences University, Portland, Oregon (OHSU) . . . 2.1
      2. NASA Johnson Space Center, Krug Life Sciences, Houston, Texas . . . 2.5
      3. University of Kansas Medical Center, Kansas City, Kansas (KUMC) . . . 2.6
      4. Medical College of Georgia, Augusta, Georgia (MCG) . . . 2.8
      5. Eastern Montana Telemedicine Project, Billings, Montana (EMTP) . . . 2.10
      6. Tripler Army Medical Center, Oahu, Hawaii (TAMC) . . . 2.11
      7. Memorial University of Newfoundland Health Sciences Center, St. John's, Newfoundland (MUN) . . . 2.13
      8. East Carolina University, Greenville, North Carolina (ECU) . . . 2.15
   B. Additional Sites Surveyed by Telephone . . . 2.16
      1. RODEO NET, LaGrande, Oregon . . . 2.16
      2. Robert C. Byrd Health Sciences Center, Morgantown, West Virginia . . . 2.17
      3. University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma . . . 2.18
      4. Stanford University, Palo Alto, California . . . 2.18
      5. Texas Tech University Health Sciences Center, Lubbock, Texas . . . 2.19
3. GENERAL DISCUSSION OF TELEMEDICINE CASE STUDIES . . . 3.1
   A. Current Status of Telemedicine . . . 3.1
      1. Telemedicine is Currently Practiced on a Small Scale . . . 3.1
      2. Teleradiology is Not Ready for Blanket Approval . . . 3.1
      3. The Effectiveness of Telemedicine Consultation Has Not Been Fully Demonstrated . . . 3.2
      4. It is Unclear Whether Telemedicine Provides Cost-Effective Access to Medical Care . . . 3.2
      5. The Medical Effectiveness of Telemedicine is Variable . . . 3.3
      6. Patient Acceptance of Telemedicine Appears to be Good . . . 3.4
   B. Issues Facing Telemedicine in the United States . . . 3.5
      1. Provider Resistance to Telemedicine . . . 3.5
      2. Administrative Support . . . 3.6
      3. Central Coordination . . . 3.7
      4. Levels of Care . . . 3.7
      5. Financial Support of Telemedicine Programs . . . 3.8
      6. Other Barriers to Expansion of Telemedicine . . . 3.8

Chapter	**Page**

4. TAXONOMY OF TELEMEDICINE APPLICATIONS 4.1
   A. Rationale for the Taxonomy 4.1
   B. A Research and Process-Based Taxonomy 4.1
      1. Applications Widely Thought to be Effective 4.1
      2. Applications That are Probably Effective, but with Unknown System Impact 4.2
      3. Applications Requiring Basic Research 4.2
      4. Applications Based on New and Untested Technologies Applied to Telemedicine 4.3

5. CONCLUSIONS: TELEMEDICINE TRENDS AND RESEARCH NEEDS 5.1

Appendix

A. REFERENCES A.1

CHAPTER 1

INTRODUCTION

A. PROJECT AND REPORT OVERVIEW

1. Project Overview

The initial purpose of this project was to examine available information on the expansion of access to care through the use of telemedicine and mobile health services. As the project developed, it was decided that telemedicine should be the exclusive focus. The primary project objective is to examine issues related to the development of a Medicare coverage policy for such services. The major consideration is whether services provided using telemedicine technologies are medically safe and effective.

The approach to the project involves literature review, development of a conceptual framework for the analysis of studies examining effectiveness, selected case studies, review of coverage policies of private third-party payers, and examination of utilization review and quality assurance/improvement models currently in operation as part of existing telemedicine systems.

Three interim reports and a final report are planned. Report 1 (Grigsby et al., 1993) covered the literature review and analytic framework. Report 2 (this report) contains case study data and presents a taxonomic system for classifying telemedicine applications with respect to their need for further evaluation. Report 3 will cover utilization review, quality assurance/improvement, and coverage policies related to telemedicine. The final report will consolidate Reports 1-3. Revisions may be made in the first three reports as a function of newly discovered literature, experience gained on site visits, and the input of study consultants. The final report will present overall conclusions and recommendations.

2. Outline of the Current Report

This is the second report of the project. It summarizes the information obtained from the case studies,, presents a taxonomic scheme developed to classify telemedicine applications, and discusses general issues in the development of telemedicine programs. Chapter 1 provides background and introductory information. Chapter 2 presents information obtained during the course of site visits. Chapter 3 is a discussion of the current status of telemedicine, and of several general issues in telemedicine. Chapter 4 presents a taxonomy of applications, and Chapter 5 contains the conclusions and summary.

B. THE CASE STUDIES

1. Approach to the Case Studies

The initial proposal called for a total of six site visits, some of which were to be to facilities using mobile health units. Because the focus of this study was shifted exclusively to telemedicine, and given the diversity of telemedicine programs, it was determined that a total of eight sites would be studied. The visits were one to three days long, depending on the complexity of the program at each site. The visits consisted primarily of interviews with individuals involved in the various telemedicine applications. Although there was some variability from one site to another, the individuals interviewed included university and hospital administrators, telemedicine program directors, technical personnel, research scientists, engineers, physicians, and other providers who had used the telemedicine systems.

The primary interest of HCFA in asking for the case studies was to determine how the system was being used, and not to study the technical specifications in detail. Nevertheless, we were shown the equipment at each site, and in most cases we observed a televised consultation or review of diagnostic images. We also had the opportunity to speak with providers at remote sites, either in person or via the telemedicine interactive television (IATV) system. Most sites arranged interviews with providers who had not used or were skeptical of telemedicine, as well as those who were enthusiastic users of telemedicine.

Because it was not possible to visit many well established telemedicine sites, we also conducted telephone interviews with several program directors whose facilities we did not visit. In particular, we were interested in obtaining data regarding costs, equipment, remote sites, staffing patterns, and medical specialties using the telemedicine system.

2. Objectives of the Case Studies

The objectives of the case studies were as follows. 1) To obtain information regarding the current practice of telemedicine. This information would include data on costs, equipment, applications, practice patterns, and acceptability of the system to providers. 2) To provide information that would permit the development of a useful taxonomy of telemedicine applications. 3) To provide a means of evaluating the adequacy of the analytic framework for assessing effectiveness that was proposed in Report 1. 4) To expand upon the information obtained from the literature review previously completed under this contract. Most of the published literature deals with teleradiology, and only by conducting several site visits would it be possible to learn more about how telemedicine is currently being practiced. 5) To familiarize ourselves with general issues facing telemedicine, and to learn how various sites attempt to deal with these issues. Based on what we learned from the visits to established telemedicine facilities, we have tried to produce a document that might be of some assistance in the development of telemedicine programs.

3. Site Selection

We initially contacted the directors of 15 telemedicine programs either by telephone, or at one of two telemedicine conferences held in the fall of 1993 (sponsored by Mayo Clinic and the Office of Rural Health Policy). We were unable to make contact with directors or other persons responsible for such decisions at two sites. After obtaining general information on telemedicine at each site, and some expression of interest in a site visit by the program director, we made our selections in collaboration with the HCFA Project Officer. At this time, the number of patients being served by telemedicine in North America is quite small. Some programs were just getting started, others were experiencing a hiatus in operations. Because of the great diversity of telemedicine programs, we determined that it would be desirable to visit programs varying on several parameters.

The programs selected varied from one another in: 1) technological sophistication (from audioconferencing to teleradiology); 2) administrative structure (Department of Defense, academic medical centers, private hospital, Canadian health care, NASA); 3) involvement in research (from none through extensive programs of clinical and basic research); 4) degree of geographic isolation (from rural states through Space Shuttle orbit and remote Pacific archipelagos); 5) range of applications; 6) source of funding (grants, appropriations, private funds, educational activities); 7) the length of time in operation (from newly begun programs through one in existence for over 20 years).

Persuasive arguments could be made for case studies at programs that were not visited, and several individuals have made such arguments. In the end, site selection was admittedly somewhat arbitrary, and we were unable to visit some highly regarded programs. Nevertheless, we believe that the case studies conducted provide a reasonable cross section of North American telemedicine facilities and programs.

CHAPTER 2

TELEMEDICINE CASE STUDIES

A. DESCRIPTION OF INDIVIDUAL TELEMEDICINE PROGRAMS

We made visits to the following eight sites, presented in the order in which they were visited. The following narratives are intended to be summaries. They include information on the overall organization of telemedicine programs, number of sites, equipment and transmission medium, capital and operational costs, primary applications, and related data. Certain specific information (e.g., costs, system capabilities, volume of patients) on these programs can be found in Table 2.1.

1. **<u>Oregon Health Sciences University, Portland, Oregon (OHSU)</u>** (site visit in November 1993)

The telemedicine program at OHSU, the Center for Advanced Telemedicine Research (CATR), is largely dedicated to research at this time. The program has been funded in part by state and federal appropriations, and recently received a grant from the National Library of Medicine for High Performance Computing and Communications (HPCC). The purpose of the grant is to develop an effective teledermatology system, and to establish the basic technical parameters for such things as resolution, data compression, and illumination necessary for accurate dermatologic diagnosis. Previous research, funded by the National Cancer Institute, has focused on the development of a digital system for mapping, diagnosing, and following dermatologic lesions, utilizing neural network technology. The work done at OHSU's program has focused primarily on assessing the effectiveness of telemedicine. Clinical telemedicine consultations have primarily involved dermatology or pediatric cardiology patients.

The program at OHSU has full motion compressed video capability. They do not have a teleradiology system. OHSU also provides some psychiatric consultation to RODEO NET (Rural Options for Development and Educational Opportunities), a telemedicine program operating in LaGrande, Oregon.

An OHSU specialist in pediatric cardiology has used real-time image transmission using ultrasound which can be compressed at a ratio of between 30:1 to 35:1. The cardiologist believes that real-time ultrasound is important so that the specialist can direct the placement of transducers and provide other necessary supervision to the technician. Some radiographic and magnetic resonance images have also been transmitted. For dermatology, the system appears to have been sufficient to provide diagnostic accuracy comparable to that of dermatologists conducting a conventional examination.

The telemedicine program is located in the Biomedical Information Communication Center (BICC) Building. The BICC is administratively independent in the University, and functions as a quasi-department. It is affiliated with the IAIMS program, and besides housing these programs, the building serves as a center for people involved in informatics and outcomes research. This has the advantage of bringing together under one roof people who are working in the fields of information and communications systems. Among the related activities in progress in the BICC are the development of patient education programs using CD-ROM and the digitization of patient data.

The telemedicine program operates on the University's fiber optic backbone. The University is affiliated with EDNET, which is a state-wide network linking over 40 sites by satellite. The Oregon legislature appropriated funds to connect all 43 rural hospitals to OHSU. Thirty of these hospitals have 50 beds or fewer. The primary purpose of this appropriation was to provide education, databases, library reference services, and communications, but it is this network that will also be used to connect telemedicine facilities. Eleven Area Health Education Centers (AHECs), where medical residents are being trained, are expected to be OHSU's first telemedicine remote sites when the program becomes operational.

As is the case for most telemedicine systems, the network is used primarily for educational and other teleconferencing purposes. A significant amount of the coursework for graduate nursing degrees is handled via teleconferencing. Because communication is done primarily by satellite and most of the ground stations are in educational institutions (rather than hospitals), the system is currently somewhat cumbersome for remote clinic and hospital sites, which must be wired into the schools.

OHSU has been a major focal point for the development of the Clinical Telemedicine Cooperative Group (CTCG). This is a consortium of telemedicine projects, the primary purpose of which is to permit collaborative research ventures. Because many of the member programs are as yet somewhat small, and may see only a few patients with particular diagnoses, the consortium provides a means of collecting data on a larger sample. Besides patients, the participating sites expect to pool research and data analysis expertise. The CTCG is seeking federal and corporate support for its programs.

2. <u>NASA Johnson Space Center; Krug Life Sciences, Houston, Texas</u> (site visit in December 1993)

Through its telemetry research, NASA has been involved in telemedicine since the early days of the manned space program. In conjunction with Lockheed Corporation and the Indian Health Service, NASA funded the Space Technology Applied to Rural Papago Health Care (STARPAHC) program on the Papago Indian reservation in the 1970s, and in recent years the agency has collaborated in providing distant medical care to countries that were part of the former Soviet Union. Our visit to NASA was confined to the offices of Krug Life Sciences, in Houston. The bulk of NASA's work is handled by contractors, and Krug is the primary life sciences contractor responsible for the development of telemedicine programs for the Space Shuttle and Space Station programs.

The telemedicine program at NASA in recent years has been limited by declining congressional appropriations to the agency as a whole. In conjunction with other contractors, NASA has primarily attempted to adapt standard, commercially-available equipment to the constraints of spaceflight. This has involved, for example, the modification of off-the-shelf products so they meet certain stringent size and weight requirements, and are capable of being used in a zero gravity environment. Video conferencing, for example, uses a standard video camera with macro lens capability for closeup examination. It appears that limited work has gone into the development of new technology.

Work in progress at NASA has involved collaboration with a number of other agencies and countries. Although the Space Shuttle represents the current manned space program of the United States, planning is underway for a multinational space station that would include Russian, Japanese, and European contributions. NASA played a major role in the Telemedicine Spacebridge program, which provided medical consultation to physicians in Armenia following that republic's catastrophic 1988 earthquake, and disaster medicine consultation has continued to be an area of focus.

The Spacebridge project used satellite communications to provide medical consultation to several Armenian regional hospitals, linking them with four American medical centers. The program utilized two-way interactive audio contact with one-way full motion video transmitted from Armenia to the United States. There were also separate data and fax transmission lines. Consultation was provided in the areas of neurology, orthopedics, psychiatry, infectious disease, and general surgery. In a separate link, consultation was also provided to the Russian town of Ufa, where a gas explosion during this same period of time caused a large number of casualties. Slow-scan black and white video was transmitted from Ufa to one of the Spacebridge sites in Armenia (Yerevan), which provided satellite uplink (Houtchens et al., 1991).

Over a 12 week period, the Spacebridge program was used to discuss the cases of 209 patients. According to data reported by Houtchens et al. (1991), the use of telemedicine was responsible for changes in the management of a large number of patients. For the 185 Armenian patients discussed, the authors noted that diagnoses were changed for 54 patients, new diagnostic studies were recommended for 70 patients, and treatment plans were changed for 47. During the attempted coup in the second half of 1993, NASA took advantage of a videoconferencing link in Moscow that was already in place to provide consultation regarding several casualties of small arms fire. This link was part of the U.S./Russian Telemedicine Demonstration Project, which consisted of 18 different sessions dedicated to different medical specialties.

NASA has been involved in the development of a range of medical devices that could be utilized in space flight. These include a system for radiography, a device that provides noninvasive blood chemistry data on a number of variables, and a hyperbaric chamber. Current plans for the Shuttle and the Space Station make it unlikely that any of these will be used. They have also developed a small kit that includes ultrasound equipment, and some research was conducted on echocardiography. Other research has been done using a fundus camera for the detection of retinal pathology. For the Space Station, there are apparently plans to employ a defibrillator, ventilator, and advanced cardiac life support equipment. Technology developed by NASA and Krug Life Sciences using public funding is not proprietary, and NASA's Technology Utilization Office is involved in developing commercial applications for certain equipment. These are often publicized in *NASA Tech Briefs*, a magazine published periodically by NASA.

Krug Life Sciences has developed a training program that would enable astronauts who are not medically trained to be qualified providers of remote telemedicine services (i.e., able to conduct a basic examination for consulting physicians on earth). Complicating the provision of such services is the fact that the astronauts must learn to perform these tasks in a zero gravity environment. NASA has recently developed the capacity for private medical conferencing from orbiting spacecraft to earth stations. Prior to this, telemedicine consultations had to be done on radio or video channels that were potentially open to the public. In the current system, the transmitted data are highly scrambled and transmitted to the Johnson Space Center via White Sands Missile Base. These one-way (Shuttle to earth) video and two-way audio signals are received in unscrambled form only by the chief medical officer in Houston, protecting the confidentiality of astronauts and allowing NASA to limit the media coverage of medical problems in space.

3. <u>University of Kansas Medical Center, Kansas City, Kansas (KUMC)</u> (site visit in December 1993)

The telemedicine program at the University of Kansas Medical Center began in 1988, initiated by a pediatrician from central Kansas who felt a growing sense of isolation from subspecialty consultants. Unlike most telemedicine programs, this one was begun without a significant educational component. Instead, the primary emphasis was on clinical consultation. The project is conducted in conjunction with the Kansas AHEC program, and during the most recent year, 930 hours of use were dedicated almost equally to telemedicine consults, educational programming, and administrative use.

At the time of this site visit, KUMC was operating as the central hub for a program involving five remote sites. Some of these sites, like the one in Hays, Kansas, are also served by outreach clinics involving subspecialists who fly in periodically from Kansas City. During the time the KUMC program has been in operation, over 500 patients have been examined by telemedicine. The telemedicine system at KUMC has been described in general terms by Allen, Cox, and Thomas (1992).

The state of Kansas leases T1 lines from AT&T, and one-quarter of this bandwidth is used for telemedicine transmission. The system utilizes compressed video and two channels of audio, so that voice and cardiac auscultation data could be transmitted simultaneously. Off-the-shelf equipment is used. The video cameras, which include 3-chip charge coupled device (CCD) cameras, can be controlled remotely. Although over 20 sites have some or all of the necessary equipment, for most of these locations the videoconferencing system is used primarily for educational purposes. Including the CODEC (for translating analog to digital signals), the cost for equipment was approximately $100,000 per site. The line access charges for many small communities vary significantly, from approximately $200 to as much as $8,000 per month. When the state network is used, KUMC is charged $20 per hour during peak use periods, and $10 per hour otherwise. It is necessary to schedule telemedicine consults in advance to arrange the availability of the necessary bandwidth. Blue Cross/Blue Shield of Kansas reimburses telemedicine consults.

Regularly scheduled clinics have not been a feature of the KUMC telemedicine program, although at the time of the site visit this was being planned, and clinics in neurology and cardiology were already being held. The first specialty to use telemedicine was pediatric cardiology. The system has since been used by several different specialties, including oncology, neurology, psychiatry and surgery (see Table 2.1). Although a few emergency consults have been obtained using telemedicine, for the most part telemedicine involves scheduled appointments. Some specialist consultants noted that they were somewhat reluctant to use telemedicine for an initial examination of a patient, but that they thought videoconferencing was particularly well-suited for followup.

Psychiatry, especially child and adolescent psychiatry, has used the system fairly regularly. One psychologist has even found that he is able to do regular (weekly for several months, and now monthly) hypnotherapy sessions with a patient while the patient's regular psychotherapist is present in the room with the patient at the remote site. It was his experience that both he and the patient became comfortable with the video link very quickly, and because it has apparently gone so well, the psychologist is interested in the possibility of doing more of this kind of work.

Neurology has used telemedicine to provide consultation regarding Parkinson's disease and dementia of the Alzheimer's type, and an assessment of some of this work has been published (Hubble, 1992; Hubble et al., 1993). The oncology service has also been using telemedicine, and has found it useful to provide patients with a videotape of the consultation. Given that patients routinely forget a significant amount of what transpires in a visit to the physician, this permits them to keep a record of the consult to which they can refer. The video system has also been used to provide training in oncology to rural nurses, since this is otherwise not available in their region, and because oncology nurses are in short supply in rural Kansas. Tumor boards have been conducted using telemedicine on three or four occasions.

While many consults are done on a physician to physician basis, nonphysician providers are more frequently involved at the remote site. For example, the oncologists generally use the system for followup on patients they have already seen in person. A nurse at the remote site operates the equipment and conducts the examination. Relevant portions of the patient chart are faxed to the specialist prior to the consult. After the physical exam, the physician is able to look at x-rays using the camera and view box or the document camera. The telemedicine system has also been used for neuropsychological assessment. Technicians in Hays examine their patients, then consult with a neuropsychologist in Kansas City regarding the exam.

The program at the University of Kansas has been noteworthy for the efforts of those who use it to conduct research into the effectiveness of telemedicine. Mattioli and his colleagues (1992), for example, evaluated the capability of the system to transmit cardiac auscultation, while Hubble et al. (1993) studied the reliability of using telemedicine for rating disability due to Parkinson's disease, using the Unified Parkinson's Disease Rating Scale (UPDRS) and the Hoehn and Yahr scale. A study by Cox et al. (1990) examined the technical requirements of a digital radiology system for the accurate reading of chest radiographs, and others at the University have been active in publishing data on telemedicine (e.g., Chaves-Carballo, 1992; Dwyer, Templeton, & Batnitzky, 1991). Some research has also been done on costs, and on patient and physician satisfaction with telemedicine. Although in some cases the sample sizes have been small, telemedicine across the country is currently practiced on a very small scale, so that large samples are hard to come by. Most programs have yet to conduct any research.

4. <u>Medical College of Georgia, Augusta, Georgia (MCG)</u> (site visit in December 1993)

The telemedicine program at the Medical College of Georgia was initiated in 1991. The funding for telemedicine at MCG has come primarily from the state, and in part involved refund money for rate overcharges by Bell South, the regional telephone company, and matching funds by Georgia Power Company. The central hub of the system is at MCG, with links to rural community hospitals, an ambulatory center, a public health facility, and correctional institutions. These links are referred to as satellites, and connection is point-to-point. At the time of the site visit, plans called for a system of hubs and spokes to cover most of the state by September 1994. This expansion will include an additional 40-50 sites, and is financed by a bill passed by the state legislature to develop both telemedicine and distance learning networks.

The statewide expansion utilizes a hub and spoke arrangement, with two tertiary care centers as hubs, nine secondary care centers as secondary hubs, and three or four primary health care facilities connected with each hub and secondary hub. Consultation may occur between the two tertiary care hubs, between hubs and secondary hubs, between secondary hubs and satellites, and between satellites.

The network involves full T1 fiberoptic transmission on a cost per usage basis. Multi-point connectivity will eventually be provided. The system utilizes standard off the shelf equipment, with 1-chip and 3-chip CCD cameras, a standard video camera, and a document camera. Special adapters allow the transmission of images from ordinary otoscopes and ophthalmoscopes. Other scopes can be equipped with a universal adaptor that provides connection with the microcamera, allowing transmission of images from endoscopes, cystoscopes, microscopes, bronchoscopes, and others. All consultations are recorded on videotape, which are maintained for risk management, quality assurance, and teaching purposes. Consultant reports are written at the conclusion of each consult and immediately faxed to the remote site. Physicians at the rural sites have access to an on-line medical literature service utilizing the PC component of the system, providing access to current medical information.

The videoconferencing equipment is remotely controllable from each end. At MCG, Telemedicine Center staff are available to operate the equipment, while providers in rural areas operate the equipment themselves. Teleradiology is provided through a number of options, including video transmission of radiographs by camera or direct digitization. At MCG, the telemedicine facility is in the vicinity of the emergency room in order to provide 24-hour access, and another site is to be added in ambulatory care.

The initial cost of equipment for the system has ranged from $90,000 to $120,000 for the hub site, and $150,000 to $175,000 for remote sites, depending on the specific equipment purchased, and the integration and maintenance requirements. Costs have reportedly decreased significantly since the program started. Line charges for the central site and four clinics are approximately $9,000 per month, and the Department of Corrections pays directly for line costs of the correctional institutions.

One of the current shortcomings of telemedicine is that the consultant is unable to palpate the patient during an examination. Instead, he or she must rely on the examiner at the remote site to provide the information that the sense of touch could otherwise convey. To address this limitation, MCG is currently collaborating with investigators at Georgia Tech to develop a "data glove" that employs virtual reality interface technology. Using the data glove, the examiner could palpate a mass and the remote consultant, with a sensing device, would be able to discriminate various characteristics of the mass, including texture and compressibility.

MCG negotiated Medicare reimbursement for telemedicine on a local basis, dealing with the medical director of Medicare's third-party payer in Georgia. That arrangement called for physician to physician contact, with reimbursement of each physician in scaled amounts ranging from $21.92 to $148.83. The reimbursement agreement is specific for the MCG Telemedicine Program. Medicaid is also reimbursing telemedicine consultations, using the same HCPCS codes assigned by Medicare, as well as a facility fee for the remote site. In addition, Blue Cross and Blue Shield of Georgia started reimbursement for telemedicine consultations in October 1993. The HCFA reimbursement agreement was suspended at one point, but is currently in effect and considered to be experimental in nature.

MCG has a well developed telemedicine protocol, and the program is actively engaged in conducting research to evaluate the effectiveness of the system. For the most part this research has not yet been published, although key personnel in the MCG program have published or presented a number of conceptual papers over the years (Sanders, 1976, 1993; Sanders & Sasmor, 1973; Sanders & Tedesco, 1993).

The telemedicine system at MCG provides medical care to a rural population that is relatively poor--a somewhat different demographic group than that served in frontier areas of Montana, for example. For these individuals, transportation to Augusta, Atlanta, or some other urban center for medical care is frequently not feasible. When they are referred for consultation, compliance is often a problem, and this can now be addressed by telemedicine.

It has been the experience of many telemedicine programs that the introduction of this technology into rural areas is viewed as a threat by many physicians and providers. There are concerns that referral networks will be disrupted, that patients will be "stolen" by specialists at urban medical centers, and that the viability of rural community hospitals will be damaged. MCG has addressed this issue in several different ways. First, they have collected data that show that approximately 85% of patients examined via telemedicine are able to be treated in their own communities in conjunction with interactive video consultation. They have also established a program whereby physicians in rural areas who use the telemedicine system are able to obtain Category 1 CME credit for the time spent on interactive consultation. The approach has thus been to attempt to demonstrate the utility of telemedicine for rural communities.

5. Eastern Montana Telemedicine Project, Billings, Montana (EMTP) (site visit in January 1994)

Among the sites we visited, the EMTP was unique in that it was the only one established by a private hospital. Deaconess Medical Center in Billings is the hub for five remote sites in four eastern Montana towns: Miles City (two sites, one in a hospital, the other in a mental health center), Culbertson, Sidney, and Glendive. The equipment for rural sites was paid for by a $483,000 grant from the Rural Electrification Administration (REA). EMTP also received $50,000 from US West for educational programming. Line costs at the end of the trial period were expected to be in the vicinity of $8,000 per month (at $17 per mile per month) for all six sites. In order to encourage use of the system, the hospital is allowing end-users to employ the system at no cost for the first year. EMTP has negotiated reimbursement from Medicaid, and has been discussing the issue with the Medicare third-party payer and Blue Cross/Blue Shield. During the six month trial, the hospital was paying physicians $75 per consult to provide an incentive to use the system.

The system uses compressed video transmitted over DS1 (T1) lines. Although the equipment includes an electronic stethoscope and ophthalmoscope, the stethoscope had apparently never worked properly, and the ophthalmoscope provided poor quality images. EMTP does not attempt to do diagnostic quality teleradiology, but does have the capacity for some transmission of low-resolution radiographs. CT scans can be transmitted digitally, however, and are of good quality. Still microscopy images of tissue can be transmitted for frozen section studies. The videoconferencing equipment is voice-activated and the cameras automatically track whoever is speaking at the time.

Although some facilities routinely videotape all consultations, at the EMTP patients currently have a choice about whether they want the consult taped. Some consideration is being given to recording all consults. Psychiatric consultations are not recorded.

To a large extent the system is supported by nonmedical uses. Like other telemedicine programs, education, including CME, is a significant component. Videoconferencing has also been used by the judicial system. Juvenile offenders can be arraigned using the system, obviating the need for transportation back and forth between their home communities and secure juvenile detention centers.

Because of a shortage of physicians, Montana has emphasized the use of nonphysician providers of medical care. Over the past five years, the state has gone from having 18 physician assistants (PAs) to about 70. PAs in Montana are licensed and able to write prescriptions. About 12 PAs are sole providers at the present time. Nurse practitioners in Montana are completely independent and have full prescription privileges. There are about 20 full-time nurse practitioners active in Montana. Unlike PAs, they do not require the supervision of a licensed physician. It appears likely that the involvement of these "mid-level providers" will be an important element of any successful telemedicine program in states like Montana.

The telemedicine system has been used by a number of different specialties, especially psychiatry and dermatology. Over 50% of the consults are psychiatric. Mental health services are especially utilized for adolescent patients, and family therapy, discharge planning, and medication review are major activities. There are five regional community mental health centers in the 17 counties of eastern Montana, covering an area of 48,000 square miles with a population density of less than 2 people per square mile. There are no psychiatrists or inpatient psychiatric units in any of those counties, and there are only two or three child psychiatrists in the entire state.

In some rural areas there is significant resistance to using the system. In Miles City, for example, where there are two sites, only the mental health center has made any significant use of telemedicine. As a general rule, it appears that those areas that are in most need of medical providers are the most likely to use telemedicine. Culbertson, for example, has only one generalist and two physician assistants, and they are enthusiastic about the use of telecommunications for consultative purposes. Miles City, on the other hand, has a number of physicians who are concerned that telemedicine will steal patients and disrupt their referral network.

Because the specialists at Deaconess Medical Center are primarily in private practice, the lack of reimbursement is something they consider very problematic, and it clearly serves to discourage many physicians from becoming involved with the system. Some physicians express reservations about the limitations of telemedicine, making particular reference to their inability to perform any interventions using the system, and to some perceived limitations of the system's capacity for accurate imaging. Nevertheless, even those who expressed some skepticism remain interested in the potential of telemedicine. One pathologist, who provides pathology services for several rural hospitals, argued that the system is entirely adequate for frozen section coverage. He believes that videoconferencing was particularly helpful for much of the training, consultation, and administrative work he was required to do to insure that the community facilities maintain their accreditation. There appeared to be a widespread feeling that physicians would prefer to conduct initial office visits in person, but that telemedicine was extremely well-suited to followups.

6. Tripler Army Medical Center, Oahu, Hawaii (TAMC) (site visit in January 1994)

The Hawaiian Islands are the most remote island chain in the world. The distances between the various islands, although not great, make inter-island transportation somewhat problematic at times. The islands themselves are thousands of miles from other Pacific archipelagos, and transportation across these great distances is seldom immediately available. It is in this geographic context that Tripler Army Medical Center conducts its telemedicine program. TAMC has the responsibility to care for over one half-million beneficiaries (active duty military, their families, retirees and families, various federal employees, and residents of U.S.-affiliated Pacific Island jurisdictions) across the Hawaiian Islands and the Pacific.

At the present time, TAMC provides telemedicine services for persons living on several remote islands. With the recent organization of the Pacific Consortium for Telemedicine (PCT), Tripler is planning to expand its range of operations across the Pacific. The purpose of the PCT is to integrate state, national, and international agencies around the Pacific Basin and Pacific Rim, in large part to provide predisaster assistance and disaster response to an area that is prone to experiencing earthquakes, volcanoes, and typhoons. TAMC is also negotiating with the Department of State, and with the different branches of the armed services, to provide telemedicine consultation to their personnel in this geographic region.

The telemedicine system at Tripler includes both full motion video and a high resolution digital radiology system. The Medical Digital Imaging Support System (MDIS) has administrative authority for teleradiology, while other telemedicine applications are administered separately. The MDIS is an outgrowth of the AKAMAI Project, which has been congressionally funded in the amount of approximately $50 million over a five year period. The purpose of this project is to develop a sophisticated, distributed radiologic imaging network, involving facilities in Korea, Okinawa, Guam, Alaska, Japan, and Micronesia. The MDIS project office offers technologic and administrative support to the AKAMAI Project, which is separately funded through a 5-year commitment. The project is controlled, in part, by Tripler's Commanding General.

Satellite transmission is widely used, although many military satellites, because of concerns about secure transmission and availability of adequate bandwidth, do not accommodate telemedicine data. For many sites, TAMC is able to use the Defense Commercial Television Network (DCTN), for which they are not charged. Some areas are accessible only via INMARSAT (International Maritime Satellite), a 128 kilobyte system, in which case a hold and forward technology is necessary. At the present time, INMARSAT requires about 10 minutes to send a radiograph, at $6 to $20 per minute.

The services supplied to Kwajalein and Ebeye illustrate clearly the significance of telemedicine in the Pacific (Delaplain et al., 1993). Kwajalein is a small atoll in the Republic of the Marshall Islands, located about 2200 miles southwest of Oahu. It is used as a missile research facility by the US Army, and is inhabited primarily by about 3,000 employees of defense contractors and their dependents, and some military personnel. Approximately three miles from Kwajalein is Ebeye, a very small island with a third world economy and about 15,000 indigenous inhabitants. Kwajalein has an 18 bed hospital with one operating room suite, and 70 providers, including six physicians. The facility reports about 15,000 outpatient visits per year. The clinic on Ebeye is a very limited facility, with significantly fewer providers and services than are available for the less populous island of Kwajalein. When necessary, residents of Ebeye are evacuated to Oahu for specialty care at TAMC.

In the year prior to the start of a telemedicine program with Kwajalein and Ebeye, approximately $800,000 was spent on evacuation of patients from Kwajalein. Round trip air fare from Kwajalein to Oahu can be as much as $2,000 per person, and when children are evacuated a parent accompanies the child. Since only two flights a week are scheduled into and out of Kwajalein, some lodging expenses are almost always incurred on Oahu. During the time that the telemedicine system has been in operation between Tripler and Kwajalein, 112 consults were obtained in 16 different specialties, and more in dermatology than in any other specialty. Although a cost effectiveness analysis has not been conducted for this telemedicine link, staff at Tripler have estimated that somewhere between 14% and 50% of evacuations from remote Pacific sites to TAMC for medical reasons could be obviated by the widespread implementation of telemedicine.

At TAMC, telemedicine is considered to consist of three levels of care. The first, emergency care, requires urgent consultation and intervention. The second is related to medical and surgical followup, comprised largely of scheduled clinic visits. The third level is subacute care, which would cover such things as the management of fractures. This level could be handled in large part by hold and forward technology, with no need to use the studio for live consults.

Although not dependent upon Medicare reimbursement, the prevailing opinion at TAMC was that policies adopted by HCFA regarding reimbursement would influence payment for the use of their telemedicine system. The structure for paying for telemedicine is very complex given the wide range of patient populations: military personnel and their dependents, civilian defense contractors, citizens of island republics, and State Department personnel. Many of the islands are former U.S. Trust Territories, and although now independent they still receive money and administrative support from the U.S. Federal Government. Money for health care is given to the Health Ministers of the various islands, who then use it to pay for services. Up to 48% of the money thus provided covers transportation to and lodging on Oahu. The U.S. Public Health Service is also involved in providing care, staffing (but not controlling) many of the island medical clinics.

Even within the U.S. government, responsibility for payment can be difficult to establish. Military facilities can be reimbursed for providing medical care to State Department Personnel when they are located on foreign soil, but when these services are provided by an Army Medical Center located within the United States via telemedicine, the policies don't make it clear whether the State Department must pay for such care. TAMC may be reimbursed for emergency room treatment for non-beneficiary patients, but not for non-emergent care. As a result, TAMC currently does a fair amount of *pro bono* work.

The charge for telemedicine consults for eligible individuals (e.g., active duty military and their families, military retirees and their family members) is $99. This is the standard fee for both routine and emergency consults, regardless of the actual expenses. The bills are sent to either the remote medical facility or to the patient's co-insurer.

At the time of the site visit, the Pacific Consortium for Telemedicine had begun planning to establish a telemedicine site on American Samoa. This project is complicated by the large number of different governments, government agencies, and private organizations involved. It was anticipated that research to evaluate the effectiveness of the program would be incorporated into the project from the beginning.

7. <u>Memorial University of Newfoundland Health Sciences Center, St. John's, Newfoundland (MUN)</u> (site visit in January 1994)

The telemedicine program at the Memorial University of Newfoundland evolved out of a need for CME in remote areas of Newfoundland during the 1960s. Some video was used, but interactive audio conferencing for education began in the mid 1970s. Since that time, MUN has used both video and audio conferencing for a number of purposes, both educational and medical. In 1978, a one-way TV, two-way audio link was established with nine hospitals around the province. After some experience with the program, it was concluded that live television was prohibitively expensive, and two-way audio conferencing, supplemented by digitizing tablets (telewriters), became the mainstay of the system. They have used compressed video between two sites, and have done some evaluation of its use for education and transmission of medical data. Although slow-scan television is available, it is not considered satisfactory for routine telemedicine use.

The telemedicine system at MUN has been involved in a good deal of research over time. In 1981, a two channel audio link was established with an oil rig, and the feasibility of providing medical services to oil company employees on the rig was evaluated. The program appeared to be successful, and was transferred to the oil company. In 1986, they participated in a year-long satellite link to Uganda and Kenya, and had a similar link for six months to the University of the West Indies. These projects were used for medical education and transmission of some medical data. Recently, MUN has become involved in a satellite-based program (SatelLife) that provides medical education and information to physicians in developing nations, especially in Africa.

A number of factors have contributed to the involvement of MUN in telemedicine. Newfoundland is a largely rural province with seasonal high unemployment. Since the institution of a cod fishing moratorium, unemployment has increased even further. As a consequence, the province has limited money to spend on equipment and wide band transmission. In addition, the weather can be harsh, and the geography makes travel between towns difficult, especially in the winter. Despite these problems, the province has a very good telecommunications infrastructure. Newfoundland Tel has extensively upgraded the system in recent years.

MUN's program has 235 sites in 125 communities, linked by dedicated lines. Telemedicine accounts for approximately 25%-30% of the use of the system, the remainder being dedicated to education. In addition to CME, about 3500 students take university courses over the network, and approximately 50-60 hours of educational programming are scheduled each day.

The primary element of the system remains audioconferencing using narrowband networks, although the requisite equipment is in place for full motion video and T1 transmission. The cost is prohibitive, however, and the general consensus is that full motion video is ordinarily unnecessary. When video is used, it generally involves compressed video with 1/4 T1 bandwidth, or use of a document camera. MUN owns a 22 port teleconference bridge that will permit up to 22 phones to dial into the network and be part of a teleconference. Ninety per cent of the physicians in the province thus have easy access to the system by phone, and a significant amount of medical consultation takes place solely by telephone. Audio transmission is augmented by the use of "electronic blackboards" or *telewriters,* which permit transmission of freehand writing and some graphics.

The system is paid for entirely by users, with no money coming from the University for support of operations. The telemedicine users are a consortium of about 50 agencies, including private companies, the government, outpatient clinics, hospitals, and many nursing homes. All hospitals on the network pay an annual fee, determined by the size of the hospital and the services they anticipate using. Those hospitals that use telemedicine to transmit electroencephalographic data pay at a higher rate. Local sites are required to provide their own teleconferencing coordinators, who handle scheduling and operations. Approximately $1.2 million (Canadian) is spent annually in operating costs for the entire network, including annual line charges of about $450,000 (Canadian).

Slow-scan video has been used to transmit radiographic images. It is relatively inexpensive, but radiologists have expressed some reservations about the image quality, and it was estimated that the accuracy of radiologic interpretation may be reduced by 5% to 10%. At the request of the provincial health department, MUN is conducting a study of the effectiveness of prenatal ultrasound via telemedicine. A radiologist at MUN supervises a technician on the remote end by means of an audio link. The ultrasound data are captured by frame-grabbing technology and transmitted by modem at 56kbit/sec, so that it takes 8-10 seconds to send a single image. If the effectiveness of ultrasound by telemedicine is supported, this would permit rural hospitals with no radiologist to provide the service. Preliminary results suggested that there was no clinically relevant loss of data.

There are only two nuclear medicine subspecialists in the province, both at MUN. Although the equipment for nuclear medicine studies is available in some community hospitals, the radiologists prefer to obtain consultation from specialists. MUN thus offers a store and forward nuclear medicine service that relies on 19.2 kbit/sec transmission since there is no need for rapid transmission. Because the images transmitted are digital from the beginning, there is no decrease in image quality due to transmission. At present, five centers in Newfoundland have nuclear medicine equipment, but because of software incompatibility, they cannot all be integrated into one telemedicine system.

Electroencephalography has been transmitted in analog form over the standard telephone circuits, using either the dedicated teleconference network or a 2-wire dial-up link, since the early 1980s. While a technician is required to position the electrodes, the recording technician is able to test electrode contact and talk directly to the patient. At the time of the site visit, data were being analyzed from a study comparing telephone EEG tracings (transmitted to MUN from Labrador City) with conventional EEG. Although there are more artifacts than with conventional data (60 Hz interference, channel crosstalk, etc.), preliminary data suggest "excellent" reliability. EEG transmission is done in real time using standard 10 channel recording. Four to eight EEGs are transmitted a day from six different sites, and are interpreted by neurologists at MUN. Approximately 7,000 EEGs have been transmitted over the course of the program, 600-700 over the last year.

One of the primary objectives of the telemedicine program has been to use the simplest, least costly technology that will support the needs of the end users. The system has been developed so that it will be flexible, and input from users has been solicited at each stage of the various projects. Training has been emphasized for all users of the system, and it has been considered important to evaluate the effectiveness of the program when it has been financially feasible (House & Keough, 1992).

8. East Carolina University, Greenville, North Carolina (ECU) (site visit in March 1994)

The telemedicine program at ECU serves a generally poor rural area. Eighteen counties have no hospital and two have no physicians. During the period from 1983 to 1988, 37 of 100 counties had a net loss of family physicians. The eastern portion of North Carolina is poor (average income between $5,000 and $6,000) and has a very high infant mortality rate. The area around Ahoskie, one of the towns on the telemedicine system, has a large number of retired elderly persons and single mothers on AFDC. Obtaining transportation is often a problem for people in the region, and the jobs that are available are often unskilled and relatively low income (e.g., chicken processing). Sixty percent of the patients are on Medicare or Medicaid.

The medical school at ECU encourages its graduates to enter family practice and other primary care specialties, and ECU has a rural primary care residency program. The telemedicine program is used in training, and permits residents at rural sites to participate in activities (e.g., grand rounds and supervision) that are based at the medical school campus. The AHEC program is actively involved in the use of videoconferencing for education. The medical school has no hospital beds of its own, but operates in conjunction with the Pitt County Hospital. The hospital currently has a complete electronic medical record on all patients, and they are capable of archiving some radiologic images. The patient record can be transmitted along with the telemedicine consult.

The equipment used at ECU permits full motion compressed video over dedicated T1 lines. Smaller outlying regions have the ability to dial into the network, and plans call for rural physicians to have AT&T Picasso phones, capable of displaying still images, that are linked with the rural clinics. North Carolina is installing T3 lines and Asynchronous Transfer Mode (ATM) switching, and will have linked 106 sites by August 1994. While this will permit transmission of up to 30 or 40 simultaneous programs on one switch, it is expected that it will be necessary to schedule consults a few hours in advance. Digital file transfers will not need to be scheduled. The cost to use this network will be approximately $3,000 per month for 16 hours per week of video, the rates being based on the number of packets transmitted, and not on distance.

ECU was approached by the state prison system which wanted a telemedicine link that would be available 24 hours a day for emergencies. The central prison paid for the equipment, and agreed to pay $75 each for up to 10 consults a month. After an initial period of use it was clear that the system was not needed for emergencies, and a program of routine clinics was set up, a move that was opposed by private practitioners who had contracts with the prison paying up to $1000 per hour. The present arrangement pays $60 to the consultant and $14 to the medical school. Mid-level practitioners are used in the prison. The use of telemedicine means a substantial savings in the transporting of prisoners, who must be accompanied by guards and maintained in a secure area. Prison consults are videotaped, and these become part of the prisoners' medical record. Since the telemedicine link to the prison was established, litigation by prisoners for alleged inadequate medical care has decreased.

Telemedicine has been used primarily by dermatology and neurology, but several other specialties have been interested as well. Gastroenterologists have been interested, but an endoscope has not been purchased for the telemedicine program since one is available at the remote site. The Department of Psychiatry has begun a pilot program that would provide urgent and emergency consults, triaging patients for substance abuse admissions, and evaluation of child psychiatry patients. The substance abuse program will have access to residents who are on 24-hour call. It is the goal of the psychiatry department to provide consultation, evaluation and triage services since these appear to be cost-effective uses of the system given a shortage of psychiatrists in eastern North Carolina. It is believed that psychotherapy via telemedicine would not be cost-effective, and there are some concerns that the necessary rapport with patients might not be optimal. The department has submitted a grant proposal that requests money to establish a central triage station and network for substance abuse services.

Over the past two years, dermatology has used telemedicine extensively for consults at the prison (120-130 contacts). For the most part, the dermatologists are satisfied with the system, although it has been somewhat difficult getting the illumination and background lighting exactly right. One dermatologist estimated that it is possible to provide an accurate diagnosis in about 90% of cases, but noted that the lighting can be problematic. Inflammation can be particularly difficult to diagnose by telemedicine with black patients.

ECU has developed a very efficient program for scheduling uses of the system. This is a component of telemedicine that becomes quite important as the volume of consults increases, especially when the system must be shared with educational and administrative users. Using commercially available database software, a program has been devised that allows users at remote sites to schedule consults directly by logging on to a computer at ECU.

A new cable television network is being installed in the region, and there are plans to utilize this for cardiac rehabilitation. At present, only about 10% of heart surgery patients are receiving rehabilitation, in part because of inability or unwillingness to drive into Greenville for therapy. Using interactive cable, it will be possible to transmit voice and data simultaneously while patients ride exercise bikes in their homes, and a therapist can monitor up to eight patients at a time.

ECU has used the presence of videoconferencing and information transmission systems to help recruit physicians into rural practices, and there are some data to suggest that this has been successful.

B. ADDITIONAL SITES SURVEYED BY TELEPHONE

In addition to those sites described above, several other telemedicine programs were surveyed by telephone. The following narratives are brief summaries only, and are presented in the order in which they were completed. These summaries include information on the structure of telemedicine programs, number of sites, equipment and transmission medium, capital and operational costs, primary applications, and related data.

1. RODEO NET, LaGrande, Oregon

RODEO NET (Rural Options for Development and Educational Opportunities) is a telemedicine program in Eastern Oregon that was developed by the Eastern Oregon Human Services Consortium. The program was funded in large part as a demonstration project by a $700,000 grant from the Rural Health Outreach Program of the Office of Rural Health Policy. As with Oregon Health Sciences University, RODEO NET uses Oregon ED-NET's telecommunications backbone. Among the available interactive services are a one-way video, a two-way audio link, a two-way compressed video/audio/data link, and a dial-up data network that provides access to a number of data bases, bulletin boards, email, and computer conferencing.

The focus of RODEO NET is on mental health services. The project has both educational and direct services components. It provides training to mental health providers in Eastern Oregon, with didactic and interactive formats. Much of the current programming involves training for persons working with children and adolescents, who are able to obtain and upgrade certification as providers through the courses offered. Training has also been provided for graduate degrees in psychiatric nursing via the RODEO NET system.

The system has been used for a number of different purposes. Most do not involve direct provision of services, but primarily entail collateral contacts. The kinds of services available include the following: 1) *24-hour psychiatric emergency service.* This permits mental health personnel in remote sites to gain access to the on-call psychiatrist at the Eastern Oregon Psychiatric Center in Pendleton, Oregon. Management of patients by this remote crisis consultation service is considered effective in reducing the need for hospitalization and transportation to distant areas. Pre-admission arrangements can be facilitated by use of the system. 2) *Case consultation.* Telemedicine allows personnel in rural community mental health centers to consult with professionals at the Oregon State Hospital, Eastern Oregon Psychiatric Center, and OHSU Psychiatry Department. Consults may be one-time events, or may occur on an ongoing basis with regular followup. 3) *Discharge and transfer staffings.* Telemedicine eliminates the need for travel for many conferences of this sort, for both patients and professional personnel. Planning can be conducted via the videoconferencing network with no apparent limitations. 4) *Psychiatric pre-commitment and recommitment hearings.* These hearings would ordinarily entail some travel for rural judges, patients, and/or providers, but can be handled effectively using RODEO NET. 5) *Psychiatric evaluation.* The use of the system by psychiatrists has been relatively limited, and has largely been confined to medication changes, brief diagnostic consultation, and treatment planning. These services have been provided almost exclusively for adults.

RODEO NET links nine remote sites, two psychiatric facilities, and OHSU. The network is satellite based, and the charges for air time vary. Rural sites lease the equipment from Oregon EdNet, and pay a $5000 per year membership fee in addition to a charge for air time. The network is supported in part by fees for training offered over the system. At present, the equipment costs approximately $40,000 per site.

2. Robert C. Byrd Health Sciences Center, West Virginia University (WVU), Morgantown, West Virginia

The Robert C. Byrd Health Sciences Center at WVU established Mountain Doctor Television (MDTV) as a means of providing CME to isolated rural health professionals and enhancing the availability of specialty and 24-hour emergency consultation throughout the state. With hubs in Morgantown and Charleston, there are six remote sites on the network. The system uses compressed full duplex interactive video and audio transmission over T1 telephone lines.

Funding for MDTV has come in part from the Office of Rural Health Policy in the United States Public Health Service, and from the Appalachian Regional Commission. MDTV uses an electronic stethoscope, with availability of a number of different fiber optic scopes. As currently configured, the system costs approximately $100,000 per site. This provides equipment for two areas in each hospital, one for patient examination and a second for videoconferencing. Line charges were approximately $55,000 per year for four sites through February 1994. The exam room has a 3-chip CCD camera. This exam room, which contains equipment that can be controlled from a central site, was designed for examining and presenting patients, with little need for a technician. The second room, set up for teleconferencing with a 1-chip camera, can be used for CME, grand rounds, nursing classes, and related purposes. The use of teleconferencing for grand rounds and educational purposes has the additional benefit of exposing providers to the system, perhaps lowering barriers to their potential use of telemedicine.

Some transmission of radiographic images is done using a view box and 3-chip camera. This has been done with CT scans, chest films, and bone films for consultative purposes, and personnel at MDTV are evaluating the effectiveness of the system for radiologic diagnosis.

The program had a fair amount of use after it was initiated in the summer of 1993, but utilization dropped off. In part, this was thought to reflect reluctance by providers to use telemedicine because they could not be reimbursed for services provided over the network. Some rural physicians were also quite busy, and felt that the use of the system was somewhat inconvenient. To address the issue of convenience, MDTV will begin using non-physician providers to present cases to specialists, but only on referral from a rural physician. As of February 1994, about ten different specialties had been involved in telemedicine consults. At this time, all telemedicine at WVU is done from physician to physician.

3. University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma

As of February 1994, the University of Oklahoma had a teleradiology program with the hub at the Health Sciences Center and a remote site in Hugo, Oklahoma. A second program, utilizing telemedicine for retinal angiography, is currently getting underway in Ada, Oklahoma. The V.A. Medical Center in Oklahoma City is also participating in this project. Plans call for a pier-to-pier network involving 11 regional tertiary hospitals, and funds are available to equip 39 rural community hospitals. It is expected that they will become involved with the network beginning in late summer or early fall 1994. The operational costs of this system are underwritten in part by a $3.4 million grant from the Department of Commerce to pay for line charges, computer equipment, and connections. Other funding has come from the state legislature, the University, and private sources. In addition to these 39 facilities, 20 to 30 clinics, hospitals, and private practices are expected to join the network at their own expense. The arrangement with the facility in Hugo was initiated in November, 1993, and a formal contract was signed in January, 1994.

Establishing a teleradiology system first represents a good strategy for funding a startup telemedicine program since there is no mechanism for distinguishing conventional radiology from teleradiology using claims data, and unlike other aspects of clinical telemedicine, radiology is fully reimbursed. Although only one site is currently on the network, the volume of teleradiology is relatively high, with approximately 90 films (not patients) transmitted per day. These include MRI, CT, and chest films. The basic approach is to scan conventional films at a spatial resolution of 2,048 x 2,048 pixels, using a laser scanner.

Transmission is over T1 lines, and the line charges are expected to be approximately $100,000 per month for all 39 rural hospitals. The cost of the equipment is approximately $50,000 per site, including a multimedia computer ($5,000-$8,000), laser scanner ($10,000-$30,000), printer ($3,000), and bridge and hub ($6,000).

Rural facilities were very involved in the planning and design of the program. Over a six-month period, there were a number of focus groups and site visits conducted, and the Health Sciences Center worked with rural hospital organizations. Besides facilitating the development of a network that would be useful to providers in rural communities, this process also served to alleviate some of the sense of threat experienced by many providers and hospital administrators.

4. Stanford University, Palo Alto, California

The telemedicine program at Stanford, currently under development, includes domestic and international components. The domestic program is expected to be underway by late summer, 1994. It is funded in part by a grant from Pacific Bell that will cover communication charges. The program will link Stanford with three Bay Area sites, including a long-term care facility with 130 skilled nursing beds, a federally funded medical and indigent care clinic, and a multi-specialty medical group practice with about 100 physicians, mostly primary care providers. The major focis of the domestic program are to increase access to care and to develop a telemedicine program within a managed care environment. The specialties to be involved initially include cardiology, dermatology, OB/GYN, radiology, and orthopedics.

The international program, which is also in a developmental stage, is intended to provide telemedicine services to nations on the Pacific Rim, including Malaysia, Indonesia, and the Philippines. So far, an educational program has been conducted in the Philippines, but no clinical telemedicine has yet been provided. The presence of remote sites in these developing countries imposes some interesting constraints on the program since their communications infrastructures have some significant limitations. Consequently, the program must use less sophisticated technology, including the transmission of static images and the use of facsimile transmission, although this will be upgraded over time.

In association with this program is Stanford's move toward a complete electronic medical record, and a large-scale information management system. When fully operational, it is anticipated that all kinds of data--including research data, information on claims, charges, and costs, and patient medical information--will be accessible in one system. Remote sites will have access to many different kinds of medical information. Among other projects, Stanford is involved in a comprehensive study of clinical efficacy and cost effectiveness, and researchers are attempting to develop a detailed model for the study of costs related to all aspects of care for specific conditions.

5. Texas Tech University Health Sciences Center, Lubbock, Texas

The MEDNET telemedicine program was established in 1989 by the Texas Tech University Health Sciences Center. The project was initially funded by a 3-year demonstration grant of $2 million from the Federal Office of Rural Health Policy and the Health Care Financing Administration. MEDNET evolved into the telemedicine component of Texas Tech's HealthNet program, which also includes TechLink, a video conferencing network for educational and administrative purposes, linking campuses in Odessa, ElPaso, and Amarillo with the main Lubbock campus.

HealthNet uses terrestrial T1 lines to transmit compressed interactive video and slow-scan video. The network also uses facsimile transmission. For the education network, one-way satellite transmission is also used, and because of the distances covered by HealthNet, consideration is being given to a satellite link for telemedicine in the future. At present there are two remote sites for telemedicine, a rural hospital and a health clinic, approximately 300 and 400 miles from Lubbock HealthNet headquarters, respectively. A third site, using static images (Picasso phones), is being planned for use in Terlingua. Physician-to-physician contacts are widely utilized, but when few physicians are available, as in Presidio near the Mexican border, non-physician providers are often the primary care providers. Texas Tech has conducted a pilot project with state prisons in West Texas, and in the fall will begin providing telemedicine services to three West Texas prisons. Eventually it is planned that HealthNet will provide services for 33,000 prisoners in West Texas prisons.

Most of the consultation done over the telemedical system involves interactive video consultation, and as of late 1992, dermatology, trauma care, and the management of complicated pregnancies appear to have accounted for a large percentage of all consultations. Other specialties using the system include ophthalmology, orthopedics, pediatrics, neurology, and physical therapy. A small volume of teleradiology, using a 3-chip camera and the view box, is conducted using static-image (slow-scan) transmission, largely for consultative purposes.

The volume of telemedicine consultations has decreased somewhat from 1991-1992 levels, presumably because rural physicians learn enough from many consults that they require fewer referrals to specialists over time. At present, HealthNet is providing five to seven consults per month, and has done over 300 consultations over the system since 1990.

The program's basic operational costs have been supported by the Texas legislature. Some revenue is obtained from rural hospital subscriptions to the satellite educational network, and additional support comes from within the Health Sciences Center. Additional revenue is expected from the prison project once it is underway. At the start of the program, two or three years ago, the cost of equipping a rural site was between $80,000 and $100,000, but current estimates for equipment may fall in the $50,000 to $65,000 range, in large part because of the availability of a new, less expensive equipment. Line access charges are approximately $5,000 per month for HealthNet's system, including TechLink and the telemedicine sites.

As is the case for most telemedicine systems we have studied, the network is used extensively for educational purposes. CME, grand rounds, seminars and case presentations are conducted regularly via video and audio conferencing on the TechLink intercampus system. Nursing education has been emphasized, as has allied health programming, particularly on HealthNet's satellite broadcast system.

CHAPTER 3

GENERAL DISCUSSION OF TELEMEDICINE CASE STUDIES

A. CURRENT STATUS OF TELEMEDICINE

1. Telemedicine is Currently Practiced on a Small Scale

Although telemedicine has come and gone in the past, this time it has a strong probability of success. Adequate technology is available to support many applications, costs are decreasing relatively rapidly, there is considerable investor interest, and other barriers to the implementation of telemedicine systems (licensing, confidentiality, state regulation of telecommunications) are being addressed. In part, telemedicine can ride the crest of healthcare reform, but considerable political pressure is being brought to bear on behalf of telemedicine itself.

Nevertheless, very little telemedicine actually is being done. Allen (1993), for example, conducted an informal survey of the most active telemedicine programs. He estimated that, excluding very brief (3-5 minute) renal dialysis consults, "well under 1,000 patient-to physician teleconsults" were conducted during 1993 in all of North America. Many well-established programs are reporting only 3-5 patient contacts per week, and some remote sites do not use the system at all, even when it is readily available.

Repeatedly during our site visits we were told that the lack of reimbursement was a major factor holding back the growth of telemedicine. In part this is accurate, but it is not the whole story. Teleradiology is currently being reimbursed, for example, yet most digital radiology transmission systems are operational within, and not between, institutions. While there are some systems for remote radiology, radiology generally plays a small part in most telemedicine systems, and teleradiology is not widely practiced as a stand-alone application. This is in contrast to the fact that a review of the literature yields much published research on teleradiology, and little on other aspects of telemedicine. Reimbursement policy needs to be addressed, but other factors may be more significant barriers to telemedicine. We will discuss these issues later in this report.

2. Teleradiology is Not Ready for Blanket Approval

We discussed the status of teleradiology in our previous report (Grigsby et al., 1993). The transmission of data that are digital from the time of their collection (e.g., MRI, CT) appears to be straightforward. Given a reliable communications medium, there should be no loss of information during transmission. When radiologists are used to reading conventional films rather than images on a monitor, it is likely that some training and experience are necessary to insure the reliability of their interpretations, but there is no technical reason why their findings and impressions should be suspect.

The research literature does not, however, provide unqualified support for all conventional radiographic procedures. The detection of certain phenomena on chest films (e.g., pneumothorax, interstitial infiltrates) remains less accurate with digital methods than with plain films. Likewise, conventional films are superior to digital images for the detection of subtle nondisplaced fractures (Scott et al., 1993). The American College of Radiology has drafted a set of standards for the practice of teleradiology. While these are generally consistent with the findings of the literature to date, certain important issues have not been addressed.

It seems likely, as we noted in the above-mentioned report, that the importance of adequate training and experience has been overlooked. In most of the published literature, little time was spent in providing sufficient training for the radiologists participating in experiments. It was frequently assumed that an hour or less spent familiarizing participants with the software and hardware was enough, and little attention was given to the possibility that accurately reading digital radiographs involves acquisition of a perceptual skill that differs somewhat from reading analog films. Several studies used residents to interpret the images. We contend that the requirements for resolution in a teleradiology system will not be established until research has been conducted using experienced radiologists who are knowledgeable in reading digital images.

3. <u>The Effectiveness of Telemedicine Consultation Has Not Been Fully Demonstrated</u>

In our previous report, we noted that few data exist to support the effectiveness of non-radiologic uses of telemedicine. A handful of studies have been conducted, most with very small samples. In part this reflects the fact that telemedicine is such a low-volume enterprise at present that large-scale research has been impossible. In addition, with a few exceptions, those individuals who have been instrumental in developing telemedicine programs have been clinicians or administrators, and not scientists. Their focus has not been on evaluating the effectiveness of telemedicine, but on providing services to groups that previously had limited access to those services.

If it were necessary to assess the effectiveness of telemedicine solely on the basis of peer-reviewed research, we would have to conclude that neither its safety nor its effectiveness has been demonstrated. When one takes into consideration the information obtained through the case studies, however, a rather different conclusion is warranted. Further research is clearly indicated, and in some cases a considerable amount of study is needed. Telemedicine does, however, appear to have significant potential.

4. <u>It is Unclear Whether Telemedicine Provides Cost-Effective Access to Medical Care</u>

The most extreme cases make the best argument that telemedicine effectively improves access to medical care. At Tripler Army Medical Center, routine diagnostic and followup care can be made available through telemedicine, eliminating the need for unnecessary and costly travel over great distances. The potential savings in time and money are obvious in this case. Similarly, in frontier regions like Montana, it seems very reasonable to conduct a 15-30 minute psychiatric medication check by videoconference in order to avoid several hundred miles of travelling. For the unemployed or working poor in the rural south, it is likely that compliance can be improved by providing teleconsultation.

The questions that remain unanswered are concerned with the costs of providing medical care by telemedicine. In the case of Tripler, it is apparent that a $99 charge for a video consult, when no subsequent medical evacuation is required, is much less expensive than a trip to Oahu and clinic visit or hospitalization. In the rural south, it may be that a patient participates in a video consultation when she or he may not have travelled to an urban medical center to see a subspecialist. In this case, the telemedicine consult may represent an additional cost that would not have been incurred without the capacity for videoconferencing. It may also be that the patient would have arrived at the urban medical center eventually, presenting relatively late with advanced disease, requiring more costly medical care.

Whether telemedicine is cost effective has not been established. A recent study published by Arthur D. Little, Inc. (1992) is being offered as proof of the cost-effectiveness of telemedicine. A careful reading of that study, however, reveals that: 1) telemedicine was only a small aspect of a more general study on telecommunications and information transmission in medicine; 2) the data base on which conclusions about telemedicine costs were based was extremely small (one unique program in Texas); 3) the model employed addressed only circumscribed aspects of costs and benefits. The design of the study simply does not permit one to draw such sweeping conclusions.

In discussions of telemedicine's cost-effectiveness, the level of analysis (i.e., payer, patient, provider, system) is rarely specified. The administrators of telemedicine programs rightly point to such things as the savings in time due to decreased consultant or patient travel when they argue that telemedicine will save money. Yet savings for patients and providers could be offset by increased expenses elsewhere in the system. Payers thus have a legitimate interest in understanding the economic impact of reimbursement for telemedicine on their operations, and there is a strong likelihood that Medicare and other third party payers will see their costs increase. This is particularly liable to occur if the physician to physician model of teleconsultation is the one that emerges as most common, and the physicians at both sites are reimbursed. Payers may also be concerned that telemedicine increases the potential for fraud and abuse of the system.

The cost of doing telemedicine varies as a function of one's role in the system. We currently know practically nothing about the cost-effectiveness of telemedicine. We need to study its impact on every level of the system, including providers, payers, patients, and the system as a whole. In discussions of cost-effectiveness, the level addressed should be specified.

One should not anticipate that research on costs and benefits will yield quick answers. Telemedicine may have existed for 25 or 30 years, but it is in its infancy. Even many of its proponents express caution if not outright skepticism about the potential of telemedicine. Large sums of money are being invested as industry, hospitals, provider groups, and academic institutions jump on the telemedicine bandwagon. Yet a single ambulatory care clinic in a large urban public general hospital will record more patient visits in a year than all North American telemedicine centers combined. It will be quite some time before telemedicine becomes a routine, integral part of the overall system of medical care delivery. Data regarding cost-effectiveness collected during the next 5-10 years of telemedicine may bear little relationship to data collected once telemedicine is no longer a novelty.

5. The Medical Effectiveness of Telemedicine is Variable

A range of opinions exists regarding the effectiveness of telemedicine. Some assert that it is effective across the board, while others are less sanguine. Many of the concerns expressed by physicians who have used telemedicine have to do with diagnostic accuracy given the available equipment. The electronic stethoscope, for example, is viewed by some physicians as entirely adequate, while two or three cardiologists reported that they had difficulty hearing rales, and were concerned that it may not respond equally well to all frequencies. Mattioli et al. (1992) reported satisfactory results with the stethoscope, but the sample size was small. Perhaps we are safe in assuming that it is effective, but it is critical that research be conducted to determine what, if any, are its limitations.

Dermatologists expressed concern about their ability to view skin lesions accurately. Resolution, color, level and type of illumination may all affect diagnostic accuracy. Investigators at Oregon Health Sciences University are beginning to study these parameters systematically, but even when minimal standards or guidelines are established, it will be necessary to calibrate color and lighting accurately and regularly to assure optimal diagnostic quality.

For nearly every specialty, it is possible to find some area(s) about which physicians will report uncertainty. Compressed video may make the evaluation of gait or tremor difficult or impossible for neurologists. The inability to feel the carotid arteries may limit the utility of telemedicine in some cases for cardiologists or neurologists, who must then rely on the skill of the examiner at the remote location. Some ophthalmologists have indicated that they are not entirely comfortable with the quality of images of the fundus. Psychiatrists are often uncertain about the quality of the rapport established with patients in a video conference, and discuss the inability to track nonverbal behavior as accurately as they otherwise might. Overall, the physicians using telemedicine with whom we spoke believe it to be generally of good quality, allowing them to make accurate judgments in most cases. Many nevertheless convey a sense that, in specific cases, it may not be quite the equal of conventional care.

For such reasons, many physicians noted that they would prefer not to do initial examination of patients routinely via telemedicine. Followup exams, on the other hand, seem ideally suited to telemedicine. Medical and surgical followup and medication checks may not require the same degree of image clarity that physicians expect when doing an initial diagnostic exam. We found no disagreement with the idea that this was a very effective use of telemedicine.

Triage was likewise generally regarded to be an effective use of videoconferencing. The information transmitted by telemedicine is in most cases sufficient to permit a decision about such things as emergency admissions, and appropriate use of telemedicine in these cases may result in retention of many patients in rural community hospitals who might otherwise have been transferred to an urban setting. When consultants are uncertain about whether the available data support a decision to transfer the patient or not, they are likely to err on the side of caution. The use of telemedicine for psychiatric triage was regarded as very valuable. Many such decisions are in fact currently made on the basis of a telephone conversation with personnel in an ER or psychiatric unit, and telemedicine could provide the psychiatrist or psychologist with more complete information.

In emergency situations, or when no alternative services are available, telemedicine seems to be a viable option even when its diagnostic accuracy is somewhat less than that of conventional medicine. In many such situations, some medical care is arguably better than none.

Medical and surgical followup, emergency consultations, medication checks, and triage could probably all be done by means of telemedicine without loss of quality relative to conventional medical care. Some physicians have argued that research demonstrating the effectiveness of specific applications of telemedicine is unnecessary. According to one version of this argument, physicians will simply not engage in those activities that they believe are less than optimally effective because of concerns about litigation. Thus liability and "risk management" will be sufficient to regulate the services offered by telemedicine. It is our recommendation that when the effectiveness of an application is in question, research be conducted to assess its value. For those programs which appear to be effective, health services research and cost-effectiveness analysis should nevertheless be conducted.

6. <u>Patient Acceptance of Telemedicine Appears to be Good</u>

Bashshur (1978) studied patient acceptance of telemedicine in the past, and some research is currently in progress. Inquiring about the acceptability of telemedicine to patients, we found that negative reactions are very rare. Even among psychotic psychiatric patients, reports of dissatisfaction or negative responses were almost nonexistent. In most cases, it is said that after 5-15 minutes of a videoconference the participants become relatively comfortable with the medium. Some patients don't mind the televised approach at all because it makes their access to specialist care much easier.

While these reports are encouraging for telemedicine providers, we should keep in mind three points. First, the base rate for satisfaction with conventional medical care is generally quite high. People usually think their physicians are giving them good care. Second, not many people have been telemedicine patients. Third, those providers currently using telemedicine are generally those who are interested in it and most invested in making their patients comfortable. As more providers become involved in telemedicine, and as the video interaction becomes more routine, patients' perceptions may change.

B. ISSUES FACING TELEMEDICINE IN THE UNITED STATES

1. Provider Resistance to Telemedicine

Many physicians are reluctant to become involved in telemedicine. It is not possible to determine the percentage of the physician population that they represent, in part because during the course of this project we found that most physicians not directly involved in telemedicine programs appeared to be unfamiliar with telemedicine. In some cases this reluctance reflected political philosophy, as with the physician who viewed the goal of increased access to care for underserved populations as a misguided attempt to extend the reach of the welfare state. In other cases, physicians expressed reasonable concerns about whether specific aspects of telemedicine had been scientifically validated. Such concerns are best addressed by publication of well-designed research.

a. Provider resistance: unfamiliarity and inertia: One observation we made repeatedly in the course of the case studies was that patient acceptance of telemedicine is significantly greater than is physician acceptance. Those providers who are already using the system are generally believers. Those who have not yet used telemedicine, however, often have a number of reasons to continue not using telemedicine. Although lack of reimbursement may be a reason to avoid telemedicine, there are other, more significant impediments to be overcome.

One of the most basic reasons why a physician does not use telemedicine is inertia. Younger, technologically-inclined physicians are probably more likely to become involved in telemedicine than are older, established physicians or those who are not interested in computers and related technology. Some telemedicine programs have attempted to get physicians involved by providing them information about the availability of a telemedicine system. In general, this approach does not seem to work well. Inertial resistance to using telemedicine is probably best overcome by getting providers actually to use the videoconferencing facilities. Familiarizing them with the concept by televising interactive grand rounds is one way this has been approached with some success. For physicians and other providers on the remote end, getting CME credits for presenting patients is also an incentive to using telemedicine. Once a provider has participated in one or two videoconferencing or telemedicine sessions, the resistance to further participation is decreased.

In certain respects, telemedicine is currently a novelty, something that is appended to existing health care systems, but which does not function as an ordinary part of those systems. In order for telemedicine to lose its novelty status and be used routinely, providers need to be exposed to it regularly during their training. This holds true for nursing students, third and fourth year medical students, residents, fellows, physician assistants, and therapists (e.g., physical therapists, speech and language pathologists).

b. Provider resistance: the perception of a threat: Physicians in rural areas tend to respond to the introduction of telemedicine in much the same way most people respond to anything new: they think about its likely effects on themselves. In remote areas with few resources, isolated providers tend to view telemedicine as advantageous.

It provides them, and their patients, with access to expertise that is otherwise unavailable. There may be other benefits associated with the system as well, such as computerized databases, literature searches, opportunities for interaction with colleagues, and continuing medical education.

In rural areas that are not severely underserved, the reaction may be rather different. When a community has a hospital and 10-20 physicians, practice patterns are generally well established, and a referral network is in place. The intrusion of a telemedicine program may appear to threaten business-as-usual, and physicians may be concerned about the possible loss of patients and revenue. Several telemedicine programs have set up a remote facility only to find that the local physicians will not use it because they are convinced that it is a predatory ploy to steal patients.

Several commonsense measures have diminished the possible perception of threat for some telemedicine programs. It helps if the initiative to establish a telemedicine site comes from the local community and not from an urban medical center's marketing department. The applications developed should reflect the needs of the community, and not just the resources of the larger medical center. If a town has a cardiologist but no psychiatrists, it makes sense to establish a psychiatric consultation program, and not an echocardiography service. In at least one case we observed, the hospital that intended to be a hub for rural consultation went into several local communities with a ready-made package of services that were not necessarily needed. Finally, research on the effect of telemedicine on practice patterns, community hospital census, and related issues can demonstrate the actual impact of telemedicine on a community. Serious, peer-reviewed research is more persuasive than statistics compiled by marketing executives.

c. Provider resistance: benefit to individual consultants: In academic medical centers, physicians are generally on a salary and any revenue they generate goes to the practice plan. There may be little incentive to take on what appears to be additional work, especially if participation has no effect on tenure or promotion, if it involves increased clinical responsibilities with no time savings elsewhere, and if the telemedicine center is inconveniently located. In many departments, residents may be responsible for most of the telemedicine consulting, and it is residents who are likely to be on call for emergency telemedicine. When physicians are in private practice, their reimbursement for consultation becomes a significant issue, particularly if they must take time out of their schedule to go to a telemedicine studio that is located some distance from their office.

2. Administrative Support

In a large medical center, responsibility for a telemedicine program is likely to become decentralized. Because telemedicine cuts across specialty areas and academic departments, there may be no clearly drawn lines of organizational authority. As a general rule, those telemedicine programs that have prospered have been those given strong administrative support. First, the administrators of the institution have worked actively to develop and fund telemedicine. Second, the director of telemedicine has been given the authority to set policy and make decisions. Scheduling, training, and coordination of telemedicine services are centralized, and there is no question about the person(s) to whom people from inside or outside the institution need to speak about telemedicine programs. Those programs that are more decentralized, or that have no clear position in the administrative hierarchy, tend to have more difficulty in establishing themselves as credible.

Careful consideration must be given to whether the telemedicine program is considered to be the equivalent of an academic department, a division of a department, or some other administrative unit. Furthermore, the credentials of the individual(s) in charge will determine, to a large extent, the direction taken by telemedicine. Different arguments may be made in favor of a director with a background in engineering, clinical medicine, administration, or research.

3. Central Coordination

Overall coordination of the telemedicine program appears to benefit from central planning and administration, taking into consideration the unique needs of remote sites. Scheduling the system should be handled centrally, for example, but should be easily done by telemedicine coordinators at remote sites. The approach to scheduling at East Carolina University, for example, provides a good model of how this might be done. Insofar as it is practical, scheduling should accommodate providers in remote areas.

When possible, transmission of records by courier, mail, or facsimile should be kept at a minimum. Those facilities that have digitized various aspects of patient records, especially those few with a completely electronic medical record, have an advantage in this regard. The transmission of relevant portions of a patient's chart has been very cumbersome in some programs, in certain cases producing resistance to the use of telemedicine, or at least to sending/obtaining adequate historical data. Some attempt at integrating various information-intensive systems including informatics, telemedicine, patient education, and outcomes research, as at Oregon Health Sciences University (OHSU), is probably desirable.

The development of training and protocols for use of the system seems to work best when these tasks are handled centrally, with input from the remote sites. This is especially likely to be the case when a program is linked to more than two or three remote facilities.

4. Levels of Care

The three levels of care conceptualized by Tripler Army Medical Center provide a good model for organizing medical services. Emergency consultation and triage should be available for trauma, medical emergencies, and disaster situations. There should be clear policies that define what constitutes a need for this level of care, and for insuring adequate coverage. If emergency consults will preempt scheduled activities that are less urgent (e.g., clinics, CME), means for dealing with such situations must be worked out in advance. Some telemedicine programs do not anticipate doing any significant amount of emergency consultation, but those that do have tended to locate the telemedicine center in the general area of the emergency room.

The second level of care involves medical and surgical followup, and may also include diagnostic consultation. Regularly scheduled specialty clinics may be the most efficient way of managing provider, patient, and communications system time. Although a telemedicine system should have the flexibility to arrange ad hoc non-emergency consults when needed, this tends to complicate scheduling and represent a relatively inefficient use of the system. For sites involved in telepathology that do intraoperative frozen section studies, a certain amount of flexible scheduling is necessary.

The third level of care involves management of situations that do not require live consultation. Most of radiology and a significant amount of pathology falls under this heading, as does the management of many chronic disorders. Full motion or static images may be forwarded for review by a subspecialist using a store and forward system. The specialist could then review the images at his or her earliest convenience. Because line access is more expensive during ordinary daylight working hours, this approach would permit transmission during off-peak periods.

5. Financial Support of Telemedicine Programs

Although costs of equipment are decreasing, starting a telemedicine program nevertheless remains a relatively expensive venture. Many of the programs discussed above received funding from legislative appropriations and grants from agencies like the REA to purchase equipment. Now that interest in telemedicine has mushroomed, competition for startup money is intense, and such funding will be more difficult to come by.

Distance education has long been a means of supporting telemedicine services. Most telemedicine programs, in fact, represent minority users of videoconferencing systems. The revenue received from educational users is one of the most common ways of defraying some of the expenses of telemedicine. Other approaches to financing telemedicine have involved the negotiation of contracts with prisons, the judicial system (for arraignment and pretrial hearings, for example), and other administrative users. University student health centers and the medical departments of large corporations may have an interest in purchasing services, and some of the medical centers discussed in this report are negotiating with managed care providers to offer telemedicine consultation.

Because public funding for starting telemedicine programs may become more difficult to obtain, HCFA may come under pressure to develop a reimbursement policy that covers use or purchase of equipment. The development of this technology is likely to further blur the distinctions between medical care, provider education, patient information, and informatics. Clear criteria for distinguishing these different activities may be difficult to establish.

6. Other Barriers to Expansion of Telemedicine

Several other factors have emerged as impediments to the development of telemedicine systems. Although it was beyond the scope of this project to address these in detail, they include the following:

1) *The cost of access is extremely variable from one site to another, and one state to another*. Under mileage-sensitive pricing schedules, remote sites, which are often lacking the necessary resources to operate telemedicine systems, must pay more for line access the farther they are from the central hub. Rate structures vary considerably by telephone company, and there is no standardized approach to the state by state regulation of rates. Tariffs have not yet been developed for the transmission of video information.

2) *Various hardware, software, communications, and regulatory systems are incompatible*. In North Carolina, for example, East Carolina University has developed and invested in a program that relies on dedicated T1 transmission. Yet the state is moving toward ATM T3 lines, with a requirement that consults be scheduled in advance. Some states have a large number of independent telephone companies with very different equipment and operational structures. Nebraska, for example, has over 40 different phone companies.

3) *A license to practice medicine is state-specific*. A license to practice medicine in California, for example, does not automatically confer the right to practice in Colorado, yet interstate telemedicine arrangements have been set up, and these systems can be expected to proliferate. In addition, liability issues have not yet been addressed in telemedicine. There is a need for clear legal definitions of the roles of consultant and responsible provider under telemedicine, and struggles over jurisdiction for licensure are likely. If legislation does not settle questions of liability, case law will eventually do so.

4) *Minimal standards for the practice of telemedicine need to be established*. This is probably best left

to professional organizations, but in many cases sufficient data do not yet exist to support specific standards of practice. As noted above, the extent to which radiology requires extremely high resolution is not yet clear. It seems unlikely that humans can distinguish between the 1,024 levels of gray available with 10-bit contrast, for example, but the exact depth of contrast necessary has not yet been empirically established. Similarly, the importance of training and experience may be an important covariate in setting requirements for resolution.

CHAPTER 4

TAXONOMY OF TELEMEDICINE APPLICATIONS

A. RATIONALE FOR THE TAXONOMY

In studying the effectiveness of telemedicine it is helpful to have a taxonomic scheme for categorizing different applications. There are many ways to approach this task. Perhaps the most obvious is to classify telemedicine by the specialties that are using it, but this results in a large number of categories and a very limited ability to make generalizations. The taxonomy described here was developed in large part on the basis of information obtained during the course of site visits. We were interested primarily in the ways in which telemedicine was used, and only secondarily in the specialties using telemedicine. Consequently, the classification system discussed here is based on various *processes* of care rather than on specific organ systems, and on the status of specific applications in relation to current research needs.

The taxonomy we have developed contains four categories of current telemedicine applications. The first group consists of applications that are plainly effective. They can be readily defined, and their implementation would be relatively straightforward. The second group consists of applications that are likely to be effective, but the implications of implementing programs in these areas are unclear. They would require a certain amount of health services research before we really understand their impact on the health care delivery system. The third group consists of applications for which the safety and effectiveness are currently unknown, or for which basic research is required to specify requisite technical parameters. The fourth group consists of applications which at this point are entirely experimental, or which anticipate the integration of different existing advanced technologies. We have included robotics under both the third and fourth categories, since some limited clinical experimental use is already being made of surgical robots. The integration of robotics and virtual reality is somewhat more distant.

B. RESEARCH AND PROCESS-BASED TAXONOMY

1. <u>Applications Widely Thought to be Effective</u>

In general terms, these are applications that are generally regarded as safe and effective. Their utilization is expected not to radically increase payer (Medicare) costs, but coverage policy may require some pilot testing. As a rule, these applications have been used successfully in one or more telemedicine programs currently in place. Effective applications include the following:

1) *Initial urgent evaluation of patients, triage decisions, and pretransfer arrangements.* These might include emergency neurosurgical, cardiac, or trauma consultation. They would be one-time consults involving a specialist, the patient, and a primary care provider at a remote site.

2) *Medical and surgical followup and medication checks.* These might include postsurgical followup care between the specialist and patient, either with or without the primary care provider present depending on the purpose of the consult.

3) *Supervision and consultation for primary care encounters in remote sites where a physician is not*

available. These would be one-time consults with a primary care physician on one end and a nurse practitioner or physician assistant with the patient at a remote site.

The research needed here would involve specification, implementation, and monitoring of coverage policies at some or all test sites. The purpose would be to analyze the process of administration of these policies and to study the effects on costs and utilization.

2. Applications That are Probably Effective, but with Unknown System Impact

In general terms, these are applications that have not been widely used. When used, they have generally been regarded as successful, but the impact of the application on the system is unknown. Applications falling into this category include the following:

1) *Diagnostic evaluations based on history, physical findings, and available test data.* These are one-time consults which may or may not involve a physician on the remote end. Psychiatric evaluations, for example, might include only the psychiatrist and patient. Orthopedic or radiologic consults may not even involve the patient in many cases, in which situation live videoconferencing would not be required.

2) *Extended diagnostic work-ups or short-term management of self-limited conditions.* These are likely to involve less than six sessions over a period of less than six months, and many are unlikely to require the presence of a primary care physician. Examples of applications falling into this category include neurologic work-up for headaches, management of complicated pregnancy, and oncologic supervision of a short-term chemotherapy regimen.

3) *Chronic disease management for conditions requiring a specialist not available locally*. These are more open-ended in their time requirements, and would generally involve a specialist and the patient, with no need for the primary care physician to be present. Examples of such applications would include a physiatrist involved in rehabilitation of a chronic pediatric disability, a nephrologist managing dialysis, psychotherapy or psychiatric drug monitoring, and neurologic management of Parkinson's disease.

The research needed here might involve the design and implementation of demonstration projects that would permit research on system impacts, including practice patterns, medical decision making, the involvement of nonphysician providers, numbers and types of consultation, utilization, costs, and provider/patient acceptance.

3. Applications Requiring Basic Research

In general terms, these are applications for which the safety and effectiveness are unknown, or for which basic research remains to be done to specify technical parameters or standards. In some cases, it may be that the telemedicine approach requires some refinement. For most of these, there is general agreement that widespread, routine use of these applications would be inappropriate at present. Applications of this kind include the following:

1) *Procedures for which imaging standards have not yet been established, or for which the data suggest that effectiveness has not been demonstrated.* Compressed video may be inadequate for the neurologic evaluation of certain tremors or gait disturbances, for example. The detection of certain features on chest radiographs (pneumothorax, interstitial infiltrates) is not yet reliable, and neither is the detection of subtle orthopedic fractures.

2) *Technically challenging applications for which audio standards have not yet been developed.* This could include certain aspects of cardiac auscultation.

3) *Telerobotic laparoscopic surgery.*

The research needed for applications in this category would be designed and implemented to answer basic questions about safety and effectiveness, and to experiment with circumscribed aspects of various applications (e.g., research on the development of an interface for guiding robotic laparoscopic instruments).

4. Applications Based on New and Untested Technologies Applied to Telemedicine

The impetus for the resurgence of telemedicine in the 1990s has resulted in large part from advances in existing technology. The basic principles of von Neumann computers have themselves not changed significantly, but the engineering of their components has increased their speed and capacity by several orders of magnitude. This kind of change can be expected to continue, but it will be accompanied by the introduction of entirely new technologies. Computers and videoconferencing were components of the early telemedicine programs. Virtual reality interfaces and robotics were not.

As an innovative interface, current models of virtual reality are probably more hype than substance ("fake" virtual reality?). The development of massively parallel computers, and advances in virtual reality research itself, will lead to the assimilation of this technology with telemedicine in the not-too-distant future. For example, as noted earlier, the Medical College of Georgia and Georgia Tech are collaborating on a "data glove" that will permit virtual palpation of patients at a distance. Robotics is likewise on the way. The Army has plans to study telerobotic laparoscopic surgery, and surgical robots are already being tested, reportedly with significant success, in certain procedures. In hip replacement surgery, for example, there are indications that robots do at least as good a job as surgeons at drilling a hole in the femur for insertion of a steel joint prosthesis.

It is not unreasonable to expect that as this technology develops, its developers will want to introduce it into various aspects of medical care as rapidly as is feasible. It is possible that these innovations will be evaluated and regulated by the FDA as medical devices, but there is a need for development of a policy concerning their regulation. Their effectiveness along a number of other dimensions will also need to be evaluated. Because the introduction of new technologies may come quickly it seems reasonable to begin preparing for them now, in order to avoid playing catch-up at a later date. These and related issues will be assessed further in the remainder of this project.

CHAPTER 5

CONCLUSIONS: TELEMEDICINE TRENDS AND RESEARCH NEEDS

Our review of the literature on telemedicine, discussed in Report 1 (Grigsby et al., 1993), found that there were insufficient published data to support the technology's effectiveness. There has been little well-designed research conducted on the use of telecommunications technology for clinical consultation. Thus, on the basis of literature review alone, there is little to recommend most of telemedicine as it is practiced in North America. Teleradiology, on the other hand, has been extensively studied, and while diagnostic accuracy for certain conditions is somewhat deficient, there is considerable evidence that teleradiology is effective for many purposes.

Conducting a series of site visits provided us with a different perspective on telemedicine. Although relatively few patients receive medical care via this medium, most of the facilities we visited are actively involved in telemedicine consultation. The volume of patients who are "seen" by telemedicine can be expected to increase significantly as many more telemedicine programs come on line, and as hospital administrators expect existing programs to begin generating income. For most purposes, telemedicine appears to be an effective mechanism for bringing medical care to the underserved, and its proliferation will certainly benefit the rural areas of this country. There are, however, some aspects of telemedicine that have not been evaluated adequately, and it is important that these be studied. In particular, minimal standards need to be developed for the effectiveness of equipment (e.g., electronic stethoscopes), for resolution (e.g., for chest radiographs), for illumination (important for dermatology) and other parameters.

The sites we visited serve rural or otherwise geographically remote regions. From what we observed, it seems likely that telemedicine programs in such areas will increase access to medical care. It is only a matter of time, however, before telemedicine programs are active in providing care to urban residents who do not have a problem with access. It seems that such a development would be entirely consistent with the current movement toward managed care. Health maintenance organizations, for example, may find it possible to employ fewer specialists by staffing a central clinic with consultants who could examine patients at several different sites using videoconferencing.

Associated with the proliferation of telemedicine will be an increased potential for over-utilization of teleconsultation, and for abuse and fraud. Advanced planning for utilization review and quality assurance is therefore necessary, and these areas, along with reimbursement policy, will be the focus of the third report under this contract.

Telemedicine appears to be generally effective, yet because so much of telemedicine has not yet been empirically evaluated, it is important that the quality of services provided by telemedicine programs be carefully assessed. Depending on the specific application, data should be collected on medical effectiveness, practice patterns, effects on rural provider networks and hospitals, costs, and related issues. It would be very helpful to analyze outcomes as a function of various alternative staffing patterns. In Georgia, for example, telemedicine is currently reimbursed only in the case of physician to physician contact. The use of nonphysician providers should be studied as another option.

The issues of reimbursement, utilization review, and quality assurance/improvement should also be studied. Several approaches to reimbursement, for example, could be developed and instituted in different regions of the country, or in different programs. This would permit an experimental evaluation that would provide data on the costs of telemedicine to HCFA. The third major report under this contract will attempt to address these issues in a preliminary manner, discussing different policy options.

APPENDIX A

REFERENCES

Allen A: (1993) Editor's note. *The Telemedicine Newsletter*, **1**, (4) 1-3.

Allen A, Cox R, Thomas C: (1992) Telemedicine in Kansas. *Kansas Medicine*, **93**, 323-325.

Arthur D. Little, Inc: (1992) *Telecommunications: Can it help solve America's health care problems?* Cambridge: Arthur D. Little, Inc.

Bashshur R: (1978) Public acceptance of telemedicine in a rural community. *Biosci Commun*, **4**, 17-38.

Chaves-Carballo E: (1992) Diagnosis of childhood migraine by compressed interactive video. *Kansas Medicine*, **93**, 353.

Cox GG, Cook LT, McMillan JH, Rosenthal SJ, Dwyer SJ III: (1990) Chest radiography: Comparison of high-resolution digital displays with conventional and digital film. *Radiology*, **176**, 771-776.

Delaplain CB, Lindborg CE, Norton SA, Hastings JE: (1993) Tripler pioneers telemedicine across the Pacific. *Hawaii Medical Journal*, **52**, 338-339.

Dwyer SJ 3rd, Templeton AW, Batnitzky S: (1991) Teleradiology: Costs of hardware and communications. *Am J Roentgenol*, **156**, 1279-1282.

Grigsby J, Kaehny MM, Schlenker RE, Shaughnessy PW, Beale S: (1993) *Analysis of expansion of access to care through use of telemedicine and mobile health services. Report 1: Literature review and analytic framework.* Denver: Center for Health Policy Research.

House AM, Keough EM: (1992) Distance health systems--collaboration bring success: The past, present, and future of telemedicine in Newfoundland. Presented at Conference on Information Technology in Community Health (ITCH), Victoria, B.C., October 1992.

Houtchens, B.A., Clemmer, T.P., Holloway, H.C., et al. (1991) Telemedicine and international disaster response: Medical consultation to Armenia and Russia via a telemedicine spacebridge. In *International telemedicine/disaster medicine conference: Papers and presentations.* Bethesda, MD: NASA.

Hubble JP: (1992) Interactive video conferencing and Parkinson's Disease. *Kansas Medicine,* **93**, 351-352.

Hubble JP, Pahwa R, Michalek DK, Thomas C, Koller WC: (1993) Interactive video conferencing: A means of providing interim care to Parkinson's Disease patients. *Movement Disorders,* **8**, 380-382.

Mattioli L, Goertz K, Ardinger R, Belmont J, Cox R, Thomas C: (1992) Pediatric cardiology: Auscultation from 280 miles away. *Kansas Medicine*, **93**, 326-350.

Sanders JH: (1976) Increasing productivity through telecommunications. Proceedings of the NSF Symposium on Research Applied to National Needs (RANN-2). November 1976, 95.

Sanders JH: (1993) Telemedicine: Challenges to implementation. Paper presented at the Rural Telemedicine Workshop, Office of Rural Health Policy. Washington, D.C., November 1993.

Sanders JH, Sasmor L: (1973) Telecommunications in health care delivery. Proceedings of the First Symposium on Research Applied to National Needs (RANN). National Science Foundation, 167-169.

Sanders JH, Tedesco FJ: (1993) Telemedicine: Bringing medical care to isolated communities. *Journal of the Medical Association of Georgia*, **82**, 237-241.

Scott WW, Rosenbaum JE, Ackerman SJ, Reichle RL, Magid D, Weller JC, Gitlin JN: (1993) Subtle orthopedic fractures: Teleradiology workstation versus film interpretation. *Radiology*, **187**, 811-815.